CLAIMS

What is claim d is:

1. A method for spatially interpolating an image, the method comprising using the steps of a dedicated neural network for each of a plurality of different edge directions to provide an interpolated value of the image.

2. A method for spatially interpolating an image, the method comprising training a neural network to interpolate for an edge direction and then using that neural network to interpolate when approximately the same edge direction is determined.

3. A method for spatially interpolating an image, the method comprising associating a plurality of neural networks with a corresponding plurality of edge directions by training each neural network to interpolate a value based upon the associated edge direction.

4. A method for spatially interpolating an image, the method comprising the steps of:

determining an edge direction of an image at a location within the image where interpolation is desired;

selecting a neural network based upon the determined edge direction; and

interpolating a value of the image at the location using the selected neural network.

5. The method as recited in claim 4, wherein determining an edge direction comprises determining vector correlations between pixels on adjacent scan lines such that the location where interpolation is desired is between the adjacent scan lines.

6. The method as recited in claim 4, further comprising determining whether or not a viable edge direction exists, prior to selecting a neural network and when no viable edge direction exists, then selecting a neural network which was trained to interpolate when no viable edge direction exists.

7. The method as recited in claim 4, wherein selecting a neural network comprises the steps of determining which of a plurality of different neural networks is most closely associated with the determined edge direction.

8. The method as recited in claim 4, wherein selecting a neural network comprises the steps of determining which of a plurality of different neural networks is best trained to interpolate a value of the image for the determined edge direction.

9. The method as recited in claim 4, wherein selecting a neural network comprises the steps of mirroring a data set to facilitate use of a common neural network for symmetric edge directions.

10. The method as recited in claim 4, wherein selecting a neural network comprises the steps of vertically mirroring a data set to facilitate use of a common neural network for symmetric edges.

11. The method as recited in claim 4, wherein selecting a neural network comprises the steps of selecting a substantially linear neural network with one neuron.

12. The method as recited in claim 4, further comprising the steps of training a plurality of neural networks, wherein each neural network is trained to interpolate a value of an image for a predetermined edge direction.

13. The method as recited in claim 4, further comprising the steps of repeating the determining, selecting and interpolating steps so as to provide a new scan line between two old scan lines.

14. The method as recited in claim 4, further comprising repeating the determining, selecting and interpolating steps so as to provide a new scan line between two old scan lines in order to facilitate deinterlacing.

15. The method as recited in claim 4, wherein the location where interpolation is desired is defined by a pixel in the image.

16. The method as recited in claim 4, wherein the interpolated value is intensity.

17. The method as recited in claim 4, wherein the interpolated valued is color.

18. The method as recited in claim 4, wherein the edge direction is determined by correlating at a vector from one scan line proximate the location where interpolation is desired with a vector from another scan line proximate the location where interpolation is desired.

19. The method as recited in claim 4, wherein the edge direction is determined by correlating at a vector from a scan line immediately above the location where interpolation is desired with a vector from another scan line immediately below the location where interpolation is desired.

20. The method as recited in claim 4, wherein the location where interpolation is desired is between two scan lines of a video image.

21. The method as recited in claim 4, wherein the location where interpolation is desired is between two scan lines of a field of an interlaced video image.

22. The method as recited in claim 4, wherein the location where interpolation is desired is approximately centered between two scan lines of an interlaced video image.

23. The method as recited in claim 4, wherein the location where interpolation is desired is approximately centered between two scan lines of an interlaced video image and further comprising enhancing the video image with the interpolated value so as to facilitate formation of a deinterlaced video image.

24. The method as recited in claim 4, wherein inputs to the selected neural network comprise values of neighboring portions of the image with respect to the location where interpolation is desired.

25. The method as recited in claim 4, wherein inputs to the selected neural network comprise values of neighboring pixels with respect to a pixel at the location where interpolation is desired.

26. The method as recited in claim 4, wherein:

determining an edge direction comprises selecting one of 2N+1 different edge directions;

selecting a neural network comprises selecting one of N+3 neural networks; and

N+1 of the neural networks are used for interpolation when an edge direction can be configuring determined, and one of the neural networks is used for interpolation when an edge exists and the edge direction cannot be determined, and one neural network is used when there is no edge.

27. The method as recited in claim 4, wherein between approximately 40 and approximately 80 samples are provided as inputs to the neural network.

28. The method as recited in claim 4, wherein approximately 60 samples are provided on inputs to the neural network.

29. The method as recited in claim 4, wherein the neural network is trained.

30. The method as recited in claim 4, further comprising training the neural network by providing a portion of an image to the neural network.

31. The method as recited in claim 4, further comprising training the neural network by providing a portion of an image to the neural network with the weighting coefficients initially set to zero.

32. The method as recited in claim 4, further comprising training the neural network by providing a portion of an image to the neural network with a bias value initially set to zero.

33. The method as recited in claim 4, further comprising training the neural network by providing a vertically low pass filtered portion of an image to the neural network.

34. The method as recited in claim 4, further comprising training the neural network by providing a portion of an image to the neural network, the portion of the image being low pass filtered along a vertical direction to mitigate vertical components which are substantially beyond a capability of the neural network to interpolate.

34. The method as recited in claim 4, further comprising training the neural network by providing a portion of an image to the neural network, the portion of the image being low pass filtered with a cut-off frequency of approximately one fourth of a sampling frequency of the image.

35. The method as recited in claim 4, further comprising training the neural network by providing a portion of an image to the neural network and using a back propagation algorithm to vary parameters of the neural network.

36. The method as recited in claim 4, further comprising training the neural network by providing a portion of an image to the neural network and using a back propagation algorithm to vary parameters of the neural network, the back propagation algorithm using a least mean square procedure as a learning algorithm.

37. A system for spatially interpolating an image, the system comprising a dedicated neural network configured to provide an interpolated value for each of a plurality of different edge directions in the image.

38. A system for spatially interpolating an image, the system comprising:

a plurality of neural networks, each neural network configured to interpolate a value of the image for a predetermined edge direction;

an edge direction detector configured to determine an edge direction of an image at a location within the image where interpolation is desired; and

a neural network selector responsive to the edge direction detector and configured to select one of the neural networks based upon the determined edge direction.

39. The system as recited in claim 38, wherein the edge direction detector is configured to determine an edge direction by determining vector correlations between pixels on adjacent scan lines wherein the location is between the adjacent scan lines.

40. The system as recited in claim 38, wherein the edge direction detector is configured to determine whether or not a viable edge direction exists prior to selecting a neural network and when no viable edge direction exists then selecting a neural network which was trained to interpolate when no viable edge direction exists.

41. The system as recited in claim 38, wherein the neural network selector is configured to select a neural network by determining which of a plurality of different neural networks is most closely associated with the determined edge direction.

42. The system as recited in claim 38, wherein the neural network selector is configured to select a neural network comprises determining which of a plurality of different neural networks is best trained to interpolate a value of the image for the determined edge direction.

43. The system as recited in claim 38, wherein the edge direction detector is configured to mirror a data set to facilitate use of a common neural network for symmetric edge directions.

44. The system as recited in claim 38, wherein the edge direction detector is configured to vertically mirror a data set to facilitate use of a common neural network for symmetric edges.

45. The system as recited in claim 38, wherein the neural network comprises a substantially linear neural network with one neuron.

46. The system as recited in claim 38, wherein each neural network is trained to interpolate a value of an image for a predetermined edge direction.

47. The system as recited in claim 38, wherein the edge direction detector is configured to determine an edge direction by correlating at a vector from one scan line proximate the location where interpolation is desired with a vector from another scan line from proximate the location where interpolation is desired.

48. The system as recited in claim 38, wherein the edge direction detector is configured to determined an edge direction by correlating a vector from a scan line immediately above the location where interpolation is desired with a vector from another scan line immediately below the location where interpolation is desired.

49. A method for interpolating an omitted scan line between two neighboring scan lines of an interlaced image, the method comprising detecting an edge direction of the image at a selected point on the omitted scan line, selecting a neural network based upon the detected edge direction, and using the neural network to provide an interpolated value for the selected point.

50. A method for deinterlacing a video image, the method comprising:

determining an edge direction of a video image at a location within the video image where interpolation is desired, the location being intermediate two adjacent scan lines of a field of the video image;

selecting a neural network based upon the determined edge direction; and

interpolating a value of the video image at the location using the selected neural network.

51. The method as recited in claim 50, further comprising repeating the determining, selecting and interpolating steps so as to provide a new scan line between two old scan lines.

52. A device for interpolating an omitted line between two neighboring scan lines of an interlaced image, the device comprising an edge detector configured to detect an edge

direction of the image at a selected point on the omitted line, and a plurality of neural networks, each neural network configured to interpolate a value for the omitted line when a particular edge direction has been detected.

53. A system for deinterlacing a video image, the system comprising:

a plurality of neural networks, each neural network configured to interpolate a value of the video image for a predetermined edge direction;

an edge direction detector configured to determine an edge direction of an image at a location within the video image where interpolation is desired; and

a neural network selector responsive to the edge direction detector and configured to select one of the neural networks based upon the determined edge direction.

54. A display monitor comprising:

a system for deinterlacing a video image, the system for deinterlacing a video image comprising:

a plurality of neural networks, each neural network configured to interpolate a value of the video image for a predetermined edge direction;

an edge direction detector configured to determine an edge direction of an image at a location within the video image where interpolation is desired; and

a neural network selector responsive to the edge direction detector and configured to select one of the neural networks based upon the determined edge direction.

55. An image produced using a method for spatial interpolation, the method for spatial interpolation comprising:

determining an edge direction of an image at a location within the image where interpolation is desired;

selecting a neural network based upon the determined edge direction; and

interpolating a value of the image at the location using the selected neural network.

56. A deinterlaced video image produced using a method for deinterlacing, the method for deinterlacing comprising:

determining an edge direction of an interlace video image at a location within the image intermediate two adjacent scan lines of a field of the video image;

selecting a neural network based upon the determined edge direction; and

interpolating a value of the video image at the location using the selected neural network.

57. A method for training a neural network, the method comprising:

providing a non-interlaced image;

interlacing the image to form an interlaced image;

providing at least a portion of the interlaced image to the neural network;

determining an edge direction in the interlaced image at a location within the interlaced image;

selecting a neural network based upon the determined edge direction;

interpolating a value of the interlaced image at the location using the selected neural network;

comparing the interpolated value with a value from a corresponding location of the non-interlaced image to define an error value; and

modifying the selected neural network based upon the error value.

58. The method as recited in claim 57, further comprising vertically low pass filtering the interlaced image prior to comparing the interpolated value with a value from the corresponding location of the non-interlaced image.

59. A device for training a plurality of neural networks to deinterlace an image, the device comprising:

an interlacer configured to interlace a non-interlaced image and to communicate the interlaced image to a neural network;

a vertical low pass filter configured to vertically low pass filter the non-interlaced image;

a comparator configured to compare an interpolated value from the neural network to a corresponding value of the non-interlaced image from the vertical low pass filter and to provide an error signal representative of a difference between the interpolated value and the corresponding value; and

a back propagation path configured to communicate the error signal from the comparator to the neural network to facilitate modification of the neural network.

60. A medium for storing information, the medium having stored thereon a method for spatial interpolation, the method for spatial interpolation comprising:

determining an edge direction of an image at a location within the image where interpolation is desired;

selecting a neural network based upon the determined edge direction; and

interpolating a value of the image at the location using the selected neural network.

61. A medium for storing information, the medium having stored thereon an image produced using a method for spatial interpolation, the method for spatial interpolation comprising:

determining an edge direction of an image at a location within the image where interpolation is desired;

selecting a neural network based upon the determined edge direction; and

interpolating a value of the image at the location using the selected neural network.

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